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Inkjet printed liquid crystal laser arrays

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Laser emission in liquid crystals (LCs) has received significant recent attention.¹ Predominantly, these function through the phenomenon of photonic band-edge lasing in chiral nematic LCs.² Here the selective reflection band, or photonic band-gap, is designed to coincide with the fluorescence maximum of an admixed fluorescent dye. Owing to the large increase in the density of photon states at the band-edge, low threshold band-edge lasing can be observed when the system is optically pumped. The key features of this technology are narrow linewidth (< 1 nm) single-mode laser emission that can be tuned anywhere in the range from 450 nm to 850 nm, through simple modification of chiral dopant and choice of dye.³

Currently, LC laser devices are fabricated using conventional LCD technology, including the use of rubbed pre-treated alignment layers and spacer beads, for example. However, we have developed a method by which such lasers may be formed by a simple inkjet deposition process. A schematic of the process is presented in Figure 1. A polymer solution (5% to 10% w/w PVA in deionized water) was coated onto a glass slide. The LC laser mixture was ejected from a heated print head (MicroFab), held at 95°C to provide the optimum viscosity for printing, directly onto the wet polymer film. It was found that through a combination of immiscibility and surface tension, the LC droplet adopted the necessary standing helix, or Grandjean, alignment for orthogonal optical pumping and photonic band-edge lasing.

The LC mixture (4.2% BDH-1281 chiral dopant, 1% PM-597 laser dye in the nematic host BL006) was designed to lase at approximately 580 nm. Under optical excitation (532 nm Nd:YAG) the inkjet deposition process generated laser droplets with very similar emission characteristics to those obtained in conventional test cells with a threshold of 300 nJ per pulse for a spot size of 110 μm .

The inkjet process described allows for "drop on demand" deposition with the ability to create complex lasing structures, such as arrays or patterns, with arbitrary emission wavelengths in the visible and near-IR. Such photonic structures possess significant potential in applications ranging from bio-assay arrays to displays.

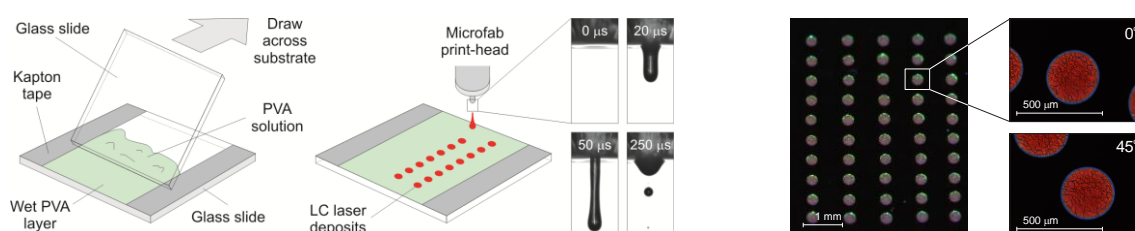


Figure 1 Schematic of the inkjet process used to create the printable liquid crystal lasers.

References:

- [1] H.J. Coles, and S.M. Morris, *Liquid-crystal lasers*, Nature Photonics, 4(10), 676-685 (2010).
- [2] V. I. Kopp, B. Fan, H. K. M. Vithana, and A. Z. Genack, *Low-threshold lasing at the edge of a photonic stop band in cholesteric liquid crystals*, Optics Letters, 23(21), 1707-1709 (1998).
- [3] P. J. W. Hands, C. A. Dobson, S. M. Morris, M. M. Qasim, D. J. Gardiner, T. D. Wilkinson, and H. J. Coles, *Wavelength-tuneable liquid crystal lasers from the visible to the near-infrared*, Proc. SPIE, Liquid Crystals XV, 8114-28, San Diego, (August 2011) 8114.

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